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INSECTS

AFFECTING THE

HACKBERRY,

(VARIOUS SPECIES OF CELTIS.)

BY

C. V. RILEY, M. A., Ph. D.

[Extracted from the Fifth Report of the U. S. Entomological Commission.]

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CHAPTER XII.

INSECTS INJURIOUS TO THE HACKBERRY.

BY C. V. RILEY.

The Hackberry is one of the most characteristic trees in our American silva. What is said of the forms growing in Missouri in my sixth report on the insects of Missouri (1874, p. 137) will apply to other parts of the country in the same latitudes—in fact, throughout its range.

Two tolerably constant forms are easily recognizable: 1. (*occidentalis* Linn.) with broad, roughish, sharply serrate leaves, purple-black drupes, and rather pale bark, which on the trunk is rough and strongly cleft so as to look as if hacked. 2. (*mississippiensis* Bosc.) with smaller, narrower, darker leaves, less serrate and often entire yellow drupes, and darker bark, the trunk appearing knotty. A third form (*crassifolia* Lamk.), having more the aspect of *Ulmus*, occurs less frequently. It is much like *occidentalis*, but with more supple limbs and rougher, thicker leaves, which, when plucked, wilt more rapidly than do those of other forms. Botanists differ as to whether these forms are specific or varietal. Dr. Gray refers them all to *occidentalis*, and, as intermediate varieties are found and the seedlings from the same tree are exceedingly variable, this seems the proper course. But Professor Planchon, who has monographed the genus, considers 1 and 2 good species, and the third doubtful.

In the report already alluded to (pp. 136 *et seq.*) under the head of "Hackberry butterflies," original accounts, with illustrations, will be found of the life-histories of two of our handsomest North American butterflies, which, so far, have been found to feed in the larval state exclusively on Hackberry. They are there treated of under the names, "Eyed Emperor" (*Apatura lycaon*), and "Tawny Emperor" (*A. herse* Fabr.), and the synonymy of the species is fully discussed and the reasons given for preferring the names of Boisduval and Le Conte (*Apatura celtis* and *Apatura clyton*). As the reasoning there has since been confirmed by the adoption of the latter names, both by Mr. W. H. Edwards and Mr. S. H. Scudder in their catalogues, these names will be used in the present instance.*

* Led by Mr. Scudder's previous writings to adopt the Fabrician names, I nevertheless took some pains to get at the real facts, and concluded, after considerable correspondence, that there was no cause to change the conclusions which I had previously expressed, that we have but two species of *Apatura* in the United States, viz: *A. lycaon* Fabr. = *celtis* Boisd. = *alicia* Edw.; and *A. herse* Fabr. = *clyton* Boisd. = *proserpina* Scudd. But I admitted that there would ever hang a certain doubt about *herse*, and that had I the paper to write over again I would use the Boisduval names, because I believe that science is better advanced by the use of names based upon descriptions of the living animals rather than by unearthing such as are drawn from pencil (and often faulty) imitations, and which admit of doubt and dispute. "In

It will be unnecessary in this connection to give more than a brief recapitulation of the results of my studies on these insects, quoting, where it may seem advisable, the more important facts from the article referred to.

1. THE EYED EMPEROR.

Apatura celtis Bd. and LeC.

A green caterpillar, with a series of pale, medio-dorsal spots and pale longitudinal lines, with two anal projections and two antlers on the head, usually found singly on the under side of the leaf, transforming to a pale green chrysalis with a serrate back. Two generations annually, the second hibernating in the second or third larval stage upon the fallen leaf. Butterfly of a russety-gray shaded with dark brown, and with eye-like spots on the wings, the female laying eggs singly or in small groups on the under surface of the leaf.

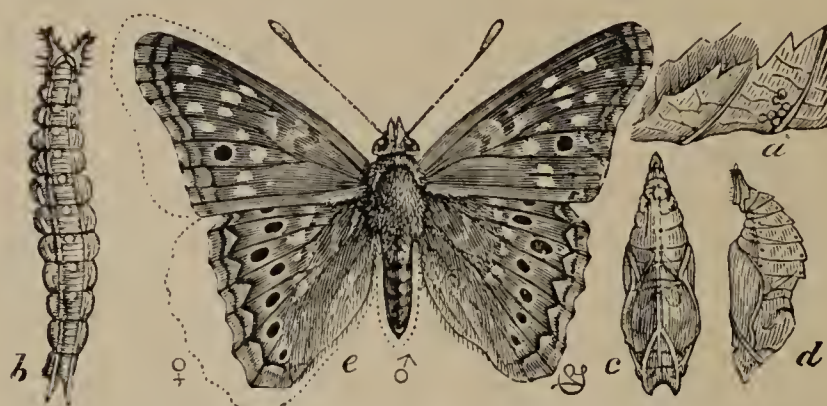


FIG. 196. *Apatura celtis*: a, eggs; b, larva, dorsal view; c, d, chrysalis, dorsal and lateral views; e, imago, male, dotted line showing form of female—all natural size. After Riley.

The larvæ of this species are found on the various species of *Celtis* during May. When at rest they are found on the under side of the leaf, usually on a carpet of silk, and often with a portion of the leaf bent around it, and they reach full maturity by the end of the month.

“In preparing for the chrysalis state the larva spins on the under side of a leaf a little bunch of silk in which to entangle its prolegs. Sometimes, but not often, it partially covers itself with a curled leaf or with two leaves drawn together. Here it rests for about two days, when the larval head and skin split open, and the soft and unformed chrysalis works them back to the extremity of its body. It then secures itself, knocks off the shrunken skin, and soon assumes the delicate green color, marked with cream yellow, and the elegant form (Fig. 196, c, d) which nature has imposed upon it.”

other words, the ‘law of priority’ becomes a nuisance and a positive injury to the science when pushed to the unnecessary extreme of attempting to solve inexplicable riddles.” Mr. A. G. Butler, of the British Museum, admitted (letter, June 15, 1874) that he was all wrong in what he had published on the subject, and concurred in my judgment. Mr. Scudder (May 29, 1874) wrote that upon examining Hübner’s *Doxocopa idyia*, it proved to be the same as a species which he had from Guatemala, and that it is barely possible that this may be *herse* Fabr.; while Mr. Edwards also wrote (July 12, 1874) that he believed *herse* not American. In his recent work, Scudder states that *idyia* [pars] Herr.-Schaeff is *clyton*, but not *idyia* Hübn., while he concludes that *celtis* is not *lycaon* Fabr., a conclusion in which I should hardly follow him, so far as the original drawings justify conclusion.

In the latitude of St. Louis it is not until the middle of June that the first butterflies begin to appear, and by the end of the month the globular, delicate, longitudinally ribbed eggs may be found on the under side of a leaf, either singly or in small clusters.

The young larva in hatching pushes open the crown, which lifts like a cap. The first summer brood of worms feeds for rather less than a month, when they transform and give out the second brood of butterflies during August.

The eggs laid by these in due time hatch, and the young larva is more lethargic than that of the first brood, feeds with less vigor, develops much more slowly, and, after passing through the second or third molt, ceases to eat, shrinks in size, and remains stationary on the under side of the leaf. It also changes from its fresh green color to a dingy grayish-brown, and eventually, with its dying support, falls to the ground and there hibernates.

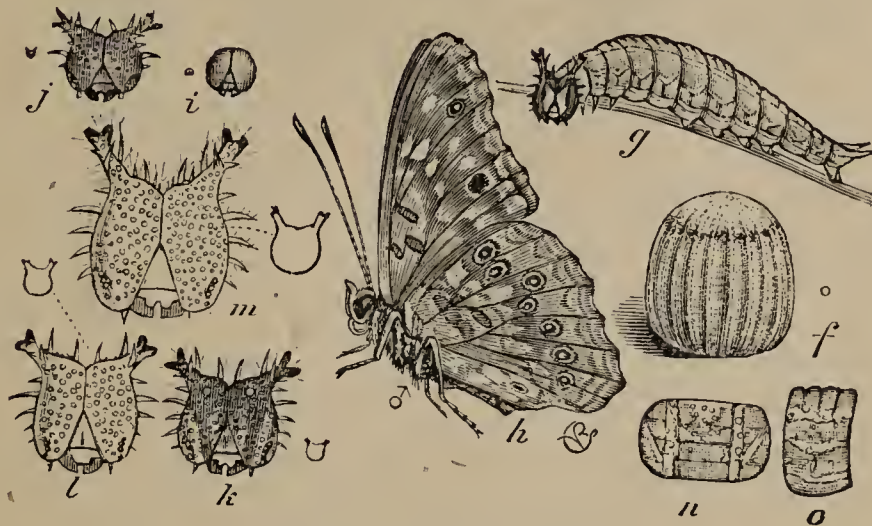


FIG. 197. *Apatura celtis*: *f*, egg, magnified; *g*, larva, lateral view; *h*, imago, underside—natural size; *i, j, k, l, m*, the five different larval heads; *n, o*, dorsal and lateral views of larval joint—enlarged. After Riley.

The accompanying figures will so fully illustrate the different stages and transformations that no repetition of description is necessary.

Parasites.—The only parasite published as attacking this species is the Ophionid, *Limneria fugitiva* Say, reared by Mr. W. H. Edwards in West Virginia, and recorded by Mr. L. O. Howard, in Scudder's Butterflies of New England, page 1883.

In 1874 I found a larva in the third stage being devoured by *Eulophus* larvæ, some of which issued and formed their pupæ under my eye, the perfect flies, an undescribed species, issuing on July 13, of that year. I have reared quite abundantly from the chrysailis of this species the large *Chalcis flavipes* Fabr. and an undescribed Tachinid, while one of my old correspondents, Mr. George W. Letterman, of Allentown, Missouri, once brought me specimens of *Podisus spinosus* which he had found piercing the larva and sucking its juices.

The egg-parasite and the other parasites reared from *Aptura clyton* and presently referred to will doubtless be found preying on *A. celtis* also.

2. THE TAWNY EMPEROR.

Apatura clyton Bd. LeC.

This butterfly is a larger and more showy one than the Eyed Emperor and it extends farther north and east. Its habits are similar and I have frequently found the larvæ of both species feeding together on the same tree.

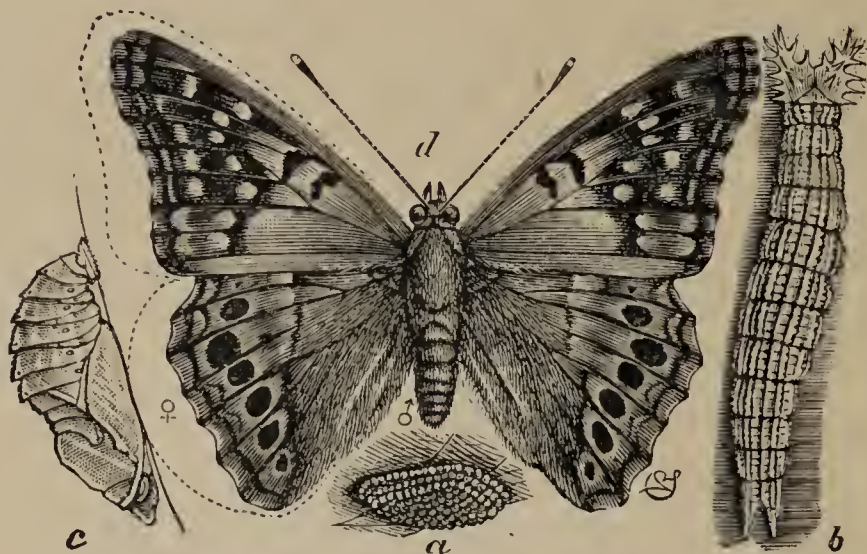


FIG. 198.—*Apatura clyton*: a, eggs; b, larva; c, chrysalis; d, imago, male, the dotted line showing form of female—all natural size. After Riley.

It is less common than *A. celtis* and Boisduval gives *Prunus* as the food-plant of the species; but no one since has recorded it as occurring on trees of that genus, and, as I have already recorded, young larvæ refused to feed on Plum leaves and died rather than eat them.

The eggs of this species are similar to those of *celtis*, and differ mainly in being narrower on the crown, but they are “invariably deposited in dense patches of from 300 to 500, and two, or more often three, tiers deep.”

The structural differences between the young larvæ of the two species are fully set forth in the article alluded to.

“The larvæ are more or less gregarious up to the third molt, after which they scatter. The habit, after they scatter, of hiding within leaves drawn around them, is more determined than in *A. celtis*; and the young of the second brood fall with the leaf, and hibernate huddled together in companies of five and upwards (Fig. 199, q). They have a habit, before separating, of feeding side by side, eating the leaf from the tip downward, but leaving the stouter ribs. Spinning a thread wherever they go, they often, in traveling from leaf to leaf, make quite a pathway of silk; and if the branch be suddenly jarred, they will drop and hang suspended in mid-air, and, after re-assurance, climb up again with the thoracic legs.”

Parasites.—My notes would indicate that there were two parasites affecting the eggs of this butterfly, one of them not preserved, and referred to the Trichogrammidæ in my fifth Missouri report. The other, since bred in numbers, proves to be a Proctotrupid belonging to the

genus *Telenomus* and described recently by Mr. Howard, in Mr. Scudder's Butterflies of New England, under the name *Telenomus rileyi*.

Besides this egg-parasite I have reared from the pupa, *Chalcis flavi-*



FIG. 199.—*Apatura clyton*: *g*, larva, half grown, dorsal view; *h*, imago, male, underside—natural size; *i, j, k, l, m*, the five different heads of larva; *n, o*, dorsal and lateral views of larval joint; *p*, egg—enlarged; *q*, larvæ as when hibernating.—natural size. After Riley.

pes Fabr. and *Pimpla annulipes* Brullé, while *Limneria fugitiva* Say was reared from the larva by Mr. A. H. Mundt in Illinois, all recorded in Mr. Scudder's work.

3. THE INTERROGATION BUTTERFLY.

Grapta interrogationis Fabr.

A spiny, reddish-brown caterpillar, more or less speckled with white, feeding on the leaves in July.

The very full life-history and bibliography of this species in Scudder's recent elaborate work, "Butterflies of New England," leaves very little, if anything, to be recorded.

The species is by no means rare in Missouri, where it first came under my observation, and while common on the Elm and Hop, is more rarely, yet not infrequently, met with on the Hackberry, as I have frequently observed it on this tree.

The following facts are extracted from notes made in 1870:

The egg with its nine vertical ribs is at first dull bluish-green, afterward becoming grayish-green with silvery reflections. It is laid singly or in chains, one above another, either on the upper or lower portion of a leaf.

The duration in the egg state is four days. Two eggs which I saw a female lay on a leaf May 19, hatched May 23, and the spines on the young larva could be distinctly discerned through the delicate egg-shell before hatching. The length of the egg was .95^{mm}; width .7^{mm}.

The full-grown caterpillar has the body black, covered with light yellow papilliform points, which are thickest and of a deeper yellow toward the head. It is also

covered with compound spines; two on each side of the second segment black, proceeding from a red wart; two on each side of the third segment, the main stem being red at base, yellow at extremity, and those proceeding from it being black. On all the other segments but the last two (on each side of which there are two compound black spines) there are seven, three on each side and one on the back. That on the back is yellow and smaller than the rest; those nearest this are also yellow, but with black extremities, particularly toward the head; those below these last have a red stalk with black spines proceeding from it, and those along the stigmatal line (which line is very light yellow) are of the same color as that line and very small. Two lines run along the back, closest together near the spines and having the appearance of a succession of links. There are also other lines running parallel with these, but not so distinct, along the sides. Head perpendicular, free, larger than the body, very dark purple-brown, and covered sparsely with small white points from which proceed fine white bristles; on the top it has two black compound spines. Thoracic legs same color as head, the prolegs of a lighter brown. Length, $1\frac{1}{2}$ inches; diameter, one-fifth inch.

It hangs by the cremaster and anal prolegs* to a small bunch of flesh-colored silk, and changes to a chrysalis similar in form to others of its group, of a fleshy-brown color shaded with bluish-black. It has a crescent-shaped projection on the thorax, with four golden spots just below. The wing-sheaths are faintly green, having a slight resemblance to a leaf.

Some specimens of the larva are much brighter than others, being speckled or mottled all over with white, and the chrysalis, instead of having four golden, has often four brilliant, silvery, metallic spots, while the whole body may be tinted with gold and green, particularly along the stigmata.

Mr. Scudder says:

Judging from the dates given by Harris's correspondence, the chrysalis state lasts from eleven to seventeen days. Grosse (Canada) says eleven days. Edwards (in West Virginia), seven to eleven. Braun, in Bangor, had them hang twenty days at the end of July.

My specimens at St. Louis remained nine days, on the average, in the chrysalis state, which is most frequent in July, while the butterflies are most numerous in August. The butterfly, therefore, appears in Missouri about the same time as in the New England States, viz, from the last of July to the middle of August, and is probably but two-brooded.

Parasites.—Two parasites are found in the eggs, *Telenomus graptæ* Howard, reared at Washington, and *Trichogramma intermedium* Howard, reared by Mr. Scudder at Cambridge. An undescribed *Apanteles* and *Pteromalus vanessæ* Harris are quite frequently reared, the one from the larva, the other from the chrysalis. *Tetrastichus modestus* Howard is a secondary parasite on the *Apanteles*, while a large Ichneumonid, *Hoplismenus morulus* Say, was once reared from it by Miss Pierce at Cambridge, all recorded in Mr. Scudder's work.

*See a paper by the author on the "Philosophy of the pupation of Butterflies," Proc. Am. Ass. Adv. Sc., for 1879, vol. 28, pp. 455-463.

4. BACHMANN'S LIBYTHERA.

Libythea bachmanni Kirtland.

This remarkable looking diurnal, appearing as if snouted, from the very long porrect palpi, so far as we now know, feeds exclusively upon *Celtis* in its larval state. The butterfly expands about $1\frac{3}{4}$ inches. It is brownish-black above, the apex of front wings quadrate, the margin slightly sinuate. There are three white spots on the apical third of the wing, the basal spot the largest and oblique. At the base of the wing are three large reddish or fulvous blotches, one of which occupies most of the discal cell. Beneath, the wings are brownish, the apex tinted with lilac, the apical white spots repeated as well as the fulvous blotch in the cell. The hind wings have a fulvous band behind the middle, and are lilaceous beneath.

Its life history was partially worked up by Mr. W. H. Edwards in *Butterflies of North America* (Vol. II, Part I, 1874), and subsequently more fully, by the same author, in the *Canadian Entomologist* (Vol. XIII, 1881, page 226), and from these the following abstract is largely drawn.

It is quite common in the Atlantic States, where its food-plant is abundant, and specimens have been captured in Canada.

It is more rare in the Mississippi Valley, but occurs as far west as Arizona. I have found it, as has also Mr. Schwarz, tolerably abundant in Texas, the larva feeding on the leaves of *Celtis*.

The oblate-spheroid, pale-green egg has eighteen or twenty narrow but prominent ribs, terminating before reaching the summit and crossed by many striæ.

Mr. Edwards says:

The eggs seem to be nearly always laid on the tender terminal leaves of the branch. Usually one egg is laid at the end of a branch, in one of the forks on the leaf stem, but I have seen two eggs on same stem, and occasionally an egg laid on the under side and middle of a leaf. The young larvæ on hatching ascend to the extremity of one of the leaves and remain there stripping the sides, leaving the midrib untouched, whence it is easy to find them. They eat their way out of the egg a little below the tip, but do not eat the egg-shell after emerging, and the empty shell has often guided me to the whereabouts of the young caterpillar.

It will be unnecessary to repeat here Mr. Edwards's description of the larval changes, but I reproduce his description of the full-grown larva and chrysalis:

Mature larva.—Seven-tenths to nine-tenths inch; cylindrical, thickened at segments 3 and 4, the dorsum of last segment abruptly curved down to the end; color dark green, the lowerside and also feet and legs pale green; each segment four times creased transversely, and on the flat ridges so caused are rows, one to each, of small tubercular flattened points, pale or whitish yellow; from 2 to 13 a white stripe along base, just over the spiracles, and above this the ground is yellowish for a little way; a medio-dorsal yellow line and sometimes a fine line on middle of side; yellow tuberculated points over the legs, in arcs of from 3 to 6; on foremost ridge of third seg-

ment, high on the side, a dead black tubercle, a little raised and rounded in yellow ring; spiracles in black ovals; surface covered with a fine short down; head obovoid, green, smooth, sparsely pilose; the ocelli brown. Occasionally the larvæ in later stages are differently colored. One had the dorsum dark green, edged on either side by a gray line, and successively by a band of yellow, a gray line, and a black band; the third segment is wholly and the fifth partly black. Two others of the same brood were green with a black band along base of body and black patches on 3 and 11.

Chrysalis.—Length, .5 inch; helmet-shaped; compressed laterally, the abdomen somewhat carinated; mesonotum high rounded, sloping abruptly to top of head-case, much compressed and sharply carinated; followed by a deep excavation; head-case not prominent, square or nearly so at top, a little excavated, the corners subpyramidal and scarcely at all produced; along carina of abdomen a yellow line which forks and passes round mesonotum to top of head-case; a slight yellow lateral line on abdomen; color green, either deep or with a blue or yellow tint; the abdomen much sprinkled with pale yellow flat points or small spots, a few of these about the head-case. Duration of this stage five days in July, seven days in August.

Mr. Edwards is of the opinion that there are several successive generations, "probably four, that the latter butterflies hibernate, and the survivors are on the wing early in May, and probably in favorable seasons in April. The first generation in descent from the hibernating females are on the wing in June, the second generation in July, the third in August, and late butterflies emerge from chrysalis in September, and these would be of the fourth generation in descent from the hibernating females."

5. THE HACKBERRY DAGGER.

(*Acronycta rubricoma* Guen.)

Order LEPIDOPTERA; family NOCTUIDÆ.

This is a widely distributed species and doubtless coincident with its food-plant, the different species of *Celtis*, on which, according to my own observations as well as those of others (French, 6th Rept. Ill. State Norm. Univ., p. 45, and J. Marten, Trans. Dept. Agr., Ill., Vol. 18, Append., p. 132), it feeds exclusively. It will, in fact, perish rather than partake of any other food that I have so far offered. The species has been represented in the U. S. National Museum from the following States: Texas, Missouri, Illinois, South Carolina, Virginia, and even from Canada, in all of which localities it is probably double-brooded. In its southern range the first brood of larvæ appear during the early part of May, being full grown by about the end of June. The moths from these appear during July and the early part of August, whilst the larvæ of the second brood are full grown from the middle of September to the middle of October, this last brood being, however, very generally parasitized. The second generation of moths (with the exception of a few premature specimens which issue the same fall) makes its appearance the ensuing spring from about the 10th of April till May. Captured specimens in the National collection bear the following dates: By myself, April 20, 1874, July 10, 1874, and September 3, 1874; by Belfrage, Texas, April 11, 21, 29; by S. H. Saunders, Canada, July 10, 1886. The full-grown larvæ are rather handsome insects, which, like

so many of the *Acronyctas*, are in the habit of resting in a curved position. The chief peculiarity of the larva is that it changes the color of its tufts and hairs at the last larval molt.

OTHER LEPIDOPTERA.

Some other Lepidoptera occur on the Hackberry, but none of them are peculiar to it except, perhaps, the Tortricid and the Tineids. It will suffice therefore, in closing this brief chapter, to indicate some of the species which occur on *Celtis*, and which also occur on other trees and have been already treated of by Dr. Packard in other chapters of this report.

6. *Pædisca celtisana* Riley (Trans. Ac. Sc. St. Louis, 1882.)

7. *Lagoa opercularis* Abbott and Smith.—Never very common, but widespread and a general feeder. My notes show that it occurs also on Oak, Orange, Apple, Pear, Plum, Viburnum, Poplar, Willow, Sassafras, English Ivy, and one has even been found on *Ailanthus*—a tree affected by so very few insects.

8. *Sphinx drupiferarum* Abbott and Smith.—This is also a not very common but widely distributed species occurring from Florida to Canada and from the Atlantic States to the Mississippi, while varieties are found in the extreme Western States, in California, and even in Vancouver. While its principal food plant seems to be *Prunus*, Abbott and Smith give also *Celtis*. Miss N. Middleton (10th Ills. Rept. on Noxious and Beneficial Insects, p. 104) also gives *Celtis* as one of its food-plants, while Professor Fernald, in his "Sphingidæ of New England," adds Apple and Lilac.

9. *Mamestra* sp.?—A larva quite closely resembling that of *Mamestra subjuncta* has been found on the Hackberry, but unfortunately not reared. The same species has also been found on *Polygonum*, Plantain, and Clover.

10. An unbred Geometrid larva resembling somewhat that of *Aletia xyliana* Say has also been found on *Celtis* at St. Catherine's Island, Georgia, by Mr. Schwarz.

11. *Proteoteras æsculana* Riley.—This species, which commonly feeds on the Buckeye, has been sent to me by Mr. L. Bruner from West Point, Nebr., on the short twigs of *Celtis occidentalis*. What is, without much doubt, the same species, has also been found upon the young shoots of Maple (*Acer dasycarpum*) as also of Box Elder (*Negundo aceroides*).

12. *Lithocolletis celtifoliella* Chambers.—This is recorded by Chambers as making a tentiform mine on the underside of the leaves of *Celtis occidentalis*.

13. *Lithocolletis celtisella* Chambers.—This species, first recorded by Chambers in 1871 (*Canadian Entomologist*, Vol. III, p. 129), I have also reared plentifully from mines on the leaves of *Celtis* collected in Virginia in 1884.

14. THE *CELTIS* GRAPHISURUS.*Graphisurus triangulifer* (Hald.).

Larva burrowing under the old bark of *Celtis texana*, partly in the bark and partly in the wood; issuing, in July, as a long-horned beetle.

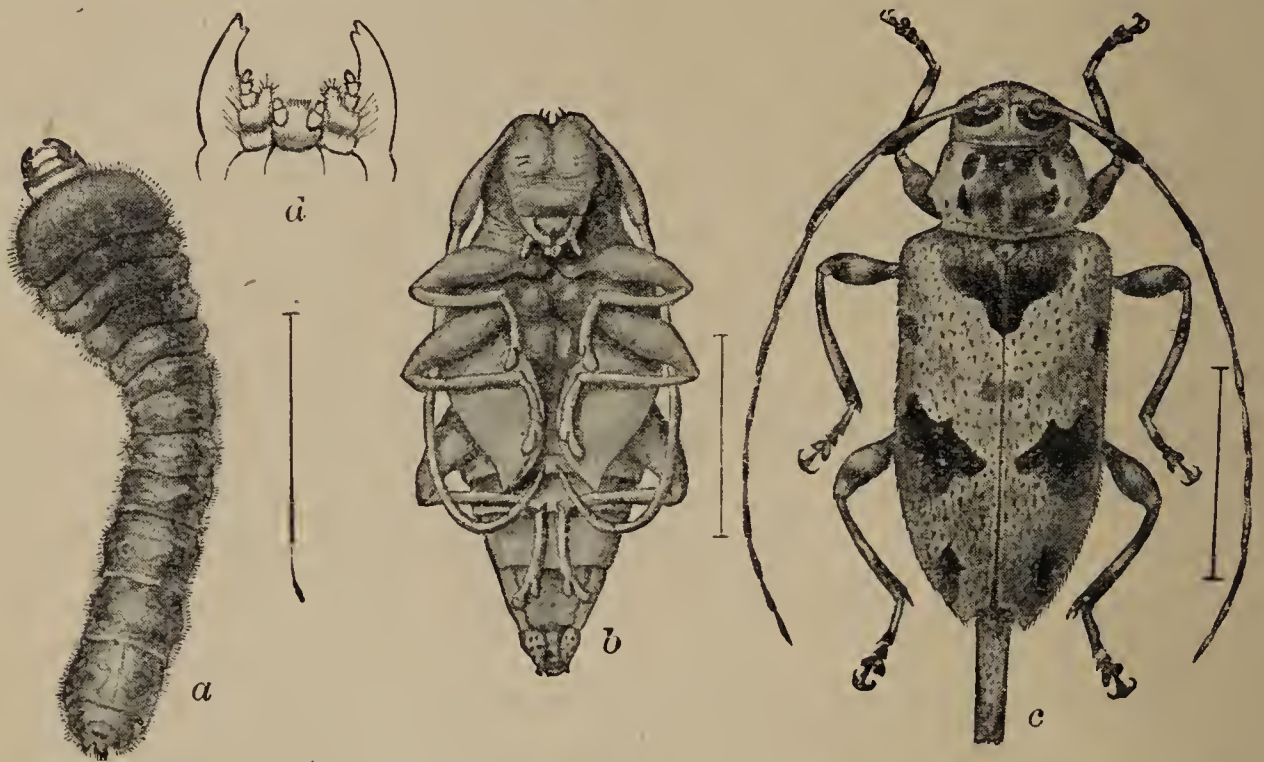


FIG. 200.—The Hackberry *Graphisurus*: *a*, larva; *b*, pupa, ventral view; *c*, female beetle—enlarged; *d*, mouth-parts of larva from beneath—still more enlarged. (Original.)

This insect is not uncommon in the Southwestern States, but was described by Haldeman in 1847 (Trans. Am. Phila. Soc., vol. x, p. 45) from specimens obtained in Alabama. It is a rather pretty beetle, about half an inch long, clothed with fine pubescence and mottled with brown and yellow, the legs and feelers annulate with yellow. Its food-habits and early states have not, I believe, heretofore been recorded. My notes of the insects obtained during the cotton-worm investigation show that it was not uncommon under the bark of the Hackberry, affecting diseased or partly dead trees, so that it injures chiefly in hastening the decay of such timber. Larvæ and pupæ were found by Mr. Schwarz at Columbus, Tex., under the bark of *Celtis texana*, June 15, 1879, and the adult insects were obtained about the end of July.

The larva and also the pupa are very similar to the like states of allied wood-borers, and any description of these states, to be of value, should be based on a comparative study of related forms. Our knowledge is too fragmentary at present to allow of such comparison and the following brief description is based merely on the species under treatment.

Larva.—Average length 22^{mm}. General color yellowish-white. Mandibles and ring about the head connecting with the base of the mandibles, reddish-brown; head a little more than one-half the width of the prothoracic joint; mandibles strongly tapering from the base, tip slightly excavated or bidentate—the lower tooth projecting somewhat beyond the upper; clypeus trapezoidal, more than twice as wide as long, marked with six deeply impressed lines; labrum rounded, tip truncated, densely clothed on exterior edge with yellowish hairs; antennæ light-colored, three-jointed; two basal joints subequal, tip of second joint truncated, armed with hairs and bearing the minute apical joint near its outer margin; labrum and maxillæ clothed with yellowish hairs; maxillary palpi apparently three-jointed, first joint

one-half longer than wide, apical joint minute; labial palpi apparently two-jointed, basal twice as long as wide, apical minute. The body tapers from the large prothoracic joint to the ninth, the last three joints slightly enlarged; tip of abdomen rounded and subtruncate; horny areas on dorsum, and venter of each joint as in other allied larvæ; prothoracic joint thickly armed with yellowish hairs, especially about the anterior and lateral portions; following joints sparsely armed with hairs on the lateral portions; thoracic legs wanting.

Pupa.—Female. Length, 15^{mm}; diameter, 8^{mm}. Color, yellowish-white. Viewed from above, the first thoracic joint is widest and the second narrowest. The abdomen tapers regularly to the truncate tip; abdominal joints 1 to 6 narrow, subequal; seventh as long as wide and nearly as long as the three preceding together. Dorsum of joints armed with minute brownish points; femora at tips armed with five or six minute spines tipped with yellowish hairs. The wing-cases extend to the tip of the fourth abdominal joint, posterior feet to tip of the seventh joint. The antennæ pass back of the femora of the two anterior pair of legs, turn at the tip of the wing-cases, and reach in front to the base of the middle pair of legs.

15. THE EYED ELATER OF THE HACKBERRY.

Alaus lusciosus Hope.

Order COLEOPTERA; family ELATERIDÆ.

This insect is hardly distinct from the common Eyed Elater (*Alaus oculatus* Linn.), and the larvæ and pupæ of the two species are practically identical. Some very slight differences occur in the armature of the last segment of the larvæ, but these may be variable, and at any rate are so slight as to be of no value in separating the two species.

The common species is known to pass its growing stages in the decaying wood of various trees and is mentioned by Dr. Packard on page 424.

On May 26, 1879, Mr. Schwarz found a larva of an *Alaus* under the bark of *Celtis texana* at Columbus, Tex., which may be referred with little doubt to *A. lusciosus*, as a perfect insect of this species was found at the same place in July and August.

16. THE CELTIS BARK-BORER.

Scolytus fagi Walsh.

Order COLEOPTERA; family SCOLYTIDÆ.

A whitish, thickened grub one-fourth inch long, occurring under the bark of *Celtis texana*, boring partly in the wood and changing in July into a shining black beetle about three-sixteenths of an inch long.

This beetle was described by B. D. Walsh in the Practical Entomologist, vol. 2, p. 58, February, 1867, and the following statement was made concerning its habits: "I obtained many specimens from south Illinois from what I believe was a beech."

Dr. Le Conte, in *Rhynchophora of America*, north of Mexico, gives it, on the authority of Walsh, as depredating on the Beech, but the above reference shows that this food habit can not be positively asserted of it.

I have examined the work of this insect under the bark of *Celtis texana* in Texas, and Mr. Schwarz has collected it in large numbers at Colum-

bus and made careful notes for me. It is found boring partly in the solid wood in all stages. So numerous were the insects that the pattern of the larval burrow, which is usually very characteristic in the Scolytids, was confused and undecipherable. The insect is very destructive to the tree by hastening decay, although it was not observed to attack perfectly healthy trees. The adolescent states show little that is specifically characteristic, the larva having the normal form and lacking legs.

This insect has a persistent enemy in a small predaceous beetle (*Clerus ichneumoneus*) which attacks and destroys the Scolytid when the latter emerges from its gallery and the larva of which, there is every reason to believe, also destroys the Scolytid larva.

The following additional Coleoptera are also known to affect *Celtis*, but are not peculiar to it, the most injurious being No. 20:

CERAMBYCIDÆ.

17. *Mallodon melanopus* Linn.
18. *Mallodon serrulatus* Lec.
19. *Smodicum cucujiforme* Say.
20. *Romaleum atomarium* Drury.
21. *Liopus crassulus* Lec.
22. *Ataxia crypta* Say.

SCOLYTIDÆ.

23. *Micracis rudis* Lec.
24. *Scolytus muticus* Say.
25. *Phloeotribus frontalis* Oliv.

The following species of Cucujidæ are found under the decaying bark:

26. *Catagenus rufus* Fabr.
27. *Scalidia linearis* Lec.
28. *Ino reclusa* Lec.
29. *Læmophlæus hornii* Casey.

CECIDOMYIDOUS HACKBERRY GALLS.

The Cecidomyidous galls occurring on twigs and leaves of *Celtis* often assume a close resemblance to those produced by the Psyllids and are almost as numerous in species as the latter. They have not yet been thoroughly studied, and a full description is not here intended, nor a characterization of the insects which make them and which are very difficult to rear. But a short account of a few of the more striking galls which are liable to be mistaken for those made by Psyllids will be appropriate.

30. Cecidomyidous galls on the tender twigs, either singly or placed in rows of two or more specimens; occurring also singly on the petiole or on the lower surface of the leaf. Gall usually resembling somewhat

a large egg of some diurnal Lepidopteron; short, conical, or subglobular in outline, arising from a circular, truncate base, rounded off at tip where it is furnished with a short spine or nipple; surface dark green, opaque, granulose, usually with faint and shallow longitudinal furrows and usually hirsute with short stout hairs; sides at the base with more or less distinct, irregular protuberances. The gall is not entirely sessile, but only connected with the twig at the central part of its base. A vertical section shows a single spherical cell (rarely two) having a thick whitish-yellow, hard and woody wall. Average height of gall 4^{mm} (excluding the apical spine); average diameter at base 3.4^{mm}. The gall varies in shape, some specimens being more conical, others nearly globular or even slightly depressed at tip, while others are not hairy and less opaque, the surface being covered with little pustules. The latter form possibly constitutes a distinct species.

31. Cecidomyidous galls on the tender twigs occurring either singly or in groups of two, three, four or more specimens; rarely, also, singly on the under side or even the upper side of the leaf. The gall bears a close resemblance to the winged seed-capsule (achenium) of a *Rumex*, but the wings vary in number from three to five and are often irregularly developed, while the tip always ends in a long curved spine. The wings terminate in a sharp ridge which is sometimes double. Gall opaque, not hairy, sculpture consisting of faint and irregular transverse striæ; color pale yellowish-green, at apical third usually of a more decided green and darker. A longitudinal section reveals a single large, regularly ovoid cell surrounded by a thin hard wall. Average height of gall 4.5^{mm}, excluding the apical spine; generally as wide as high; length of apical spine variable, but usually a little more than half the height of the gall.

This gall is easily recognized from its peculiar form.

32. Cecidomyidous galls on the under side of the leaf, always arising from one of the principal leaf-veins, occurring usually singly, rarely in pairs. In form, sculpture, and pubescence the gall bears a most striking resemblance to that produced by *Pachypsylla celtidis-pubescens* (see p. 619) but it is much larger, more globular, and at once distinguished by the absence of the cupuliform depression on the upper side of the leaf which is so characteristic of many *Pachypsylla* galls. A vertical cut through the gall shows a relatively small ovoid cell surrounded by a thick, hard yellowish-white wall. On detaching the gall the base is seen to be truncate and attached to the rib of the leaf by an extremely short conical style which is not visible from the sides. Average height 3.5^{mm}; diameter at middle, 3.5^{mm} to 4^{mm}.

33. Cecidomyidous galls on the under side of the leaf arising from the leaf-ribs, occurring either singly or in smaller or larger groups. Gall rosette-shaped, resembling the seed-capsule of certain Malvaceous plants of the genus *Hibiscus*, circular in outline, greatly flattened on the top and here furnished with a short central spine or median nipple (frequently broken off); sides sulcate, with from ten to twelve more or

less marked furrows, and with the corresponding interstices convex. Surface of gall not shining, lighter or darker brown, speckled with small irregular blackish pustules, and sparsely beset with moderately long whitish hairs, which are easily abraded. Average height of gall, .75^{mm}; diameter, 2 to 3^{mm}. Cell oblong oval, inclosed by thick, woody side walls, but with a thin bottom, and at the roof (*i. e.*, toward the upper side of the leaf) covered with a thin soft layer. Gall on upper side of leaf usually visible as a small circular pustule of brownish or grayish color. The gall is also at once recognizable from its shape, but might readily be mistaken for a Psyllid gall.

34. Cecidomyidous galls on the under side of the leaf, either singly or in smaller or larger numbers, usually between the leaf-veins, rarely crossing the large ribs. The gall is a more or less stout conical spine arising from a circular base, and either gradually and regularly tapering toward the tip or more suddenly narrowed a short distance from the base, and then with the sides more vertical; tip more or less acute and often slightly curved. Color pale yellowish, surface a little shining, either without distinct sculpture or with faint longitudinal furrows, especially near the base. Average height, 4^{mm}; average diameter at base, 2.8^{mm}. The walls of the gall are thin except near the base, where they are thicker; the cell is elongate ovoid, and extends from the base to the tip of the spine. On the upper side of the leaf the gall is visible as a small circular slightly depressed spot of pale color and furnished in the center with a small nipple. While issuing, the perfect insect pushes off the tip of the spine.

35. Cecidomyidous galls on the under side of the leaf arising from the leaf-veins, either singly or in groups or in rows, either assuming a vertical position or more or less reclining or even horizontally placed. Gall cylindrical, or very slightly narrowed at base; at tip always truncate with a median nipple. Color pale yellow, surface opaque, faintly longitudinally striate and usually beset with sparse, long, white hairs, which, however, are easily lost. Average height of gall, 2.5^{mm}; diameter, 1.2^{mm}. The walls are thin, the cell elongate with the apical side truncate, and the basal end conical. On the upper side of the leaf the gall is barely visible as a small yellowish spot on the veins.

This often occurs in company with the preceding species, of which it may possibly be an extreme but constant variety: at least a form which combines the characters of the two is not infrequent. It is intermediate in size, short, conical, with truncate tip and either hairy or glabrous.

HACKBERRY PSYLLIDÆ.

The Hackberry is infested by a number of gall-producing Psyllidæ which are all referable to the genus *Pachypsylla* Riley (Proc. Biol. Soc. Wash., v, 2, 1889, p. 71). The imagos are stout-bodied insects with the head vertically deflexed and rugosely punctate; vertex not narrowing anteriorly; frontal cones more or less oval, well separated from the vertex and at most half as long as the latter; antennæ stout,

and not longer than the width of the head; pronotum and dorsulum strongly ascending and rugosely punctate; anterior wings of varying form and consistency, but never hyaline; pterostigma present; tip of wing between radius and fourth furcal; marginal cells unusually long and narrow; genital plate of male more or less oval (when viewed from the side) and not linear.

The genus belongs to the subfamily Psyllinæ and has no equivalent in the European fauna; but some allied, still undescribed, genera occur in the New World.

The species of *Pachypsylla* are divisible into the following groups, the table being reproduced from my "Notes on North American Psyllidæ" (l. c., 75):

Head and dorsum opaque; front wings submembranaceous or subhyaline, not rugose; pterostigma distinct; both marginal cells very long, narrow, and of about equal size in length; anal style of full-grown larva and pupa long.

Dorsulum and mesonotum alutaceous, glabrous; front wings narrowly rounded at tip, widest in basal half; genital segment of female longer than the rest of the abdomen; anal style of full-grown larva and pupa notched at tip.

Type, *venusta*.

Dorsulum and mesonotum rugoso-punctate, with distinct but very short, sparse pubescence; front wings broadly rounded at tip, widest in terminal half; genital segment of female shorter than the rest of the abdomen; anal style of full-grown larva and pupa pointed at tip Type, *c.-mamma*.

Head and dorsum shining, without pubescence; front wings somewhat convex, basal half not wider than terminal half, broadly rounded at tip, distinctly rugose; pterostigma indistinct; marginal cells less narrow, the first shorter and somewhat smaller than the second; genital segment of female shorter than the rest of the body; anal style of full-grown larva and pupa very short, nicked at tip Type, *c.-gemma*.

For *P. c.-gemma* I have suggested the subgeneric name *Blastophysa*, but the yet undescribed species are all so closely allied to *P. c.-mamma* that they can only be distinguished with difficulty.

The distinguishing characters of the pupa, which apply also to the full-grown larva, have been alluded to in the above table, and aside from these characters the following description, taken from the pupa of the largest of our species will, in the most important points, also apply to those of the others species:

Pupa.—Broadly oval in outline; widest at middle of abdomen; depressed anteriorly; abdomen more convex. General color faint bluish-green; upper surface with indistinct rosaceous markings; antennæ and legs pale yellow; wing-pads and tip of abdomen brownish; abdominal spines black. Sculpture not obvious, surface opaque, thinly covered with long, soft, whitish and not clavate hairs, which are more numerous on the abdomen, but which do not form a fringe as seen in other genera. Upper and under sides of body somewhat sharply divided, but the sides everywhere rounded off. Head (including eyes) as wide as the mesonotum at middle; much less inclined than in the imago; anterior margin broadly rounded; frontal lobes not indicated; eyes very large, globular, finely granulated, reaching to the hind margin of the head; ocelli barely visible from above, antennæ thicker than in imago, and, therefore, apparently shorter, but otherwise not different; pronotum separated from head by a deep sulcus, not different in shape from that in imago; dorsulum much shorter than in imago; mesonotum as in imago. Wing-pads smooth, very shining, slightly diverging posteriorly, small and narrow in comparison with those of other genera,

not quite attaining apex of second abdominal joint, those of under wings slightly projecting internally and posteriorly. Abdomen composed of eight joints, widest at middle, gradually narrowing anteriorly and very strongly posteriorly; anal joint drawn out in a horny process; first joint very short, second twice as long as the first, the following three joints still longer, the fourth being the longest and widest; dorsal and ventral sides of joints 2 to 4 separated by a rounded lateral bulging; dividing sutures of segments 1 to 5 very deeply impressed; last three joints much less distinctly divided, more horny, and of darker color, rapidly narrowing posteriorly, and provided dorsally with a number of black, backwardly directed, triangular teeth, arranged as follows: Sixth joint at middle of hind margin with two or three very small teeth placed transversely and with no lateral teeth; seventh joint at middle of hind margin, with a transverse row of four teeth, and on each side with two or three (often obsolete) teeth or tubercles; anal joint with the horny process about half as long as the joint, and nicked at the tip, while at base of process on each side a lateral row of four small, closely placed teeth extends to the under side, and finally on the disk of the joint three teeth triangularly placed, the posterior being the largest; behind this group and just above the base of the process is another tooth nicked at tip.

The pupæ of the other species differ mainly from the above description in the smaller size, the form and length of the anal process, and in the number and arrangement of the abdominal teeth. That of *P. c.-gemma* alone has some other distinguishing characters.

The young larvæ of all species are of a more uniform pale color with less developed wing-pads and the segmentation of the abdominal joints much less evident; they are further distinguished by the smaller number of antennal joints and the weaker development of the abdominal armature.

The galls produced by the species of *Pachypsylla* may be distinguished as follows:

Polythalamous (very rarely monothalamous) galls, never on the surface of the leaf, always singly.

Large gall on petiole and involving the basal portion of the leaf; usually somewhat reniform in shape, and with an opening near the tip.

P. venusta O. S.

Smaller gall on the twig, bud-shaped, and without opening.

P. c.-gemma Riley.

Monothalamous galls, always on the leaf, usually occurring in great numbers.

Gall blister-like on both sides of the leaf and hardly raised above the surface of the leaf *P. c.-vesiculum* n. sp.

Gall on the under side of the leaf, not blister-like, more or less raised above the surface and assuming various shapes.

Gall on upper side of leaf, blister-like and not forming a depression; on underside of leaf star-shaped or flower-shaped.. *P. c.-asteriscus* n. sp.

Gall on upper side of leaf represented by a depression.

Gall on upper side of leaf, with the outer rim alone depressed, the central portion slightly raised and provided with a median spine; on under side of leaf wart-like, much flattened, with a more or less pronounced depression at middle *P. c.-umbilicus* n. sp.

Gall on upper side of leaf represented by a cup-like depression, the outer rim sometimes elevated.

Gall very large, mammiform without depression or rim on top, usually not pubescent, sometimes with slight down at base.

P. c.-mamma Riley.

Monothalamous galls—Continued.

Gall smaller, semi-globular, sessile, covered with long soft hair and without impression.....*P. c.-pubescens* n. sp.

Gall smaller, globular, subsessile, with a small impression at top, not pubescent.....*P. c.-globulus* n. sp.

Gall smaller, not pubescent, sessile, wider than high, very much flattened on top, and here usually with two concentric elevated rims, and provided with a central nipple.....*P. c.-cucurbita* n. sp.

Gall smaller, not pubescent, less sessile than the preceding, higher than wide, around the sides near top with longitudinal sulci, the top cup-like, depressed, and without central nipple.

P. c.-curcubita var.?

The following characteristics of the galls are condensed from more elaborate descriptions, which I hope to publish in a more complete paper on the biology of the North American Psyllidæ.

36. *P. venusta* Osten Sacken (Stett. Ent. Zeit., 1861, p. 422).—Generally globular, but often more or less irregularly ovoid, or even elongate. Color varying from pale buff to brown; surface opaque, with scattered, small, flattened postules. Diameter of globular form varying from 7 to 20^{mm}. The gall consists of an outer shell and an inner core, which can easily be separated upon cutting the gall open. The outer



FIG. 201.—Gall of *Pachypsylla venusta*: a, gall fully formed; b, same forming; c, same in section, natural size. After Riley.

shell is very hard and woody, varying in thickness from 1 to 3^{mm}. The apical portion of the gall has on one side a slit which is deepest and widest at the tip and connects here with the funnel-like, twisted, basal portion of the leaf. This slit exposes to view the inner core, which consists of the very thin and brittle walls of the irregular cells which fill

the entire cavity of the outer shell. The number of these cells varies according to the size of the gall, but is rarely reduced to a single one.

The full-grown pupa always leaves the gall through the apical opening, and in doing so has to saw its way out through the top of the inner core.

The gall usually occupies the entire petiole, but in rare instances a small portion of the latter is visible between the gall and the twig.

37. *P. (Blastophysa) celtidis-gemma* Riley.—This gall is briefly referred to but not named by Osten Sacken (l. c., pp. 422, 423.) It is much smaller than the preceding, very variable in size, and of irregular shape, but always bud-like, and looking as if formed by the conglomeration of a number of rounded nodules which are separated from the adjoining ones by shallow furrows. Color varying from light reddish-brown to dark brown or the color of the twig; surface of the young gall usually covered with a dense matting of white woolly hairs, which in the more mature gall are more or less completely lost. As in the preceding species, the gall is hard and woody, but entirely closed. It is usually opaque, rarely a little shining, the surface indistinctly sculptured, but occasionally roughened by adhering particles of the scales of the original bud. It has no inner core, and the cavity is entirely filled with the cells, which vary from one to eight in number. The outer wall is never more than one millimeter thick, often less, while the walls dividing the cells are sometimes very thin and sometimes even thicker than the outer wall. The gall occurs only on one-year-old twigs, and is formed by the young larvæ settling on and sinking into such buds as would normally produce a new twig the ensuing year. Each mature pupa saws its way through the wall of the gall in spring and changes to imago immediately after issuing.

38. *P. celtidis-vesiculum* n. sp.—This gall appears upon the upper side of the leaf merely as a flat blister of yellowish or reddish-yellow color and of irregular outline. It is generally rounded, but often influenced and limited by the larger leaf nerves, which are rarely crossed by the gall. On the under side of the leaf the gall is still less conspicuous, and is visible only as a discolored spot with a small rounded nipple in the center. The sculpture of the surface of the gall is the same as that of the leaf, and the walls are not thickened.

This gall often occurs in very large numbers on one and the same leaf, crowding one another, and often confluent. The full-grown pupæ break through the wall of the gall either on the upper or lower side of the leaf. The species is most readily recognized from the very inconspicuous appearance of the gall, and more especially from the fact that it is the only one which is hardly developed on the under side of the leaf, whereas all the other leaf-galls assume there a more or less conspicuous form.

39. *P. celtidis-asteriscus* n. sp.—This gall, on the upper side of the leaf, is very similar to the foregoing species, *i. e.*, represented only by a barely raised, blister-like spot, distinguished from the surface of the leaf mainly

by its lighter color but furnished in the middle with a moderately long spine which is sometimes clavate but readily broken off and often lost when the galls attain maturity or in dried specimens. In this case there is a more or less conspicuous nipple left in the center of the gall. The gall is normally circular in outline, but often irregular and limited by the leaf-nervules. Average diameter, 5^{mm}.; sculpture coarser than, but of the same nature as, that of the leaf. On the under side of leaf it is barely distinguishable as a slightly discolored spot, but the center rises from a thin base and, spreading out, assumes the form of a small flower (resembling somewhat that of a *Convolvulus*) or a star, and this resemblance to a flower is increased by the presence of a small, rounded, median nipple, which is often surrounded by a circular rim. Average height of this flower shaped excrescence, 1.25^{mm}; diameter at top, 2.50^{mm}. The walls of these galls are a little thicker than the leaf itself, and, as in the preceding species, the cell is a low chamber with a straight roof (*i. e.*, toward the upper surface of the leaf) and the bottom a little convex.

The mature pupa makes its way out through an oval slit always on one side of the roof of the gall.

40 *P. celtidis-umbilicus* n. sp.—This gall occurs on the upper side of the leaf, is regularly circular in outline and abruptly depressed at its outer margin beneath the surface of the leaf. From this outer margin toward the center the gall gradually rises again to about the level of the surface or even above it, the center being furnished with an elongate nipple (frequently broken off). The color in fresh specimens is a little lighter than that of the leaf, but fully developed and dried specimens are more yellow. Surface opaque, either without any decided sculpture, or rugose and with the venation of the leaf still preserved. On the under side of the leaf it is distinctly elevated, averaging 2^{mm} in height and 5^{mm} wide, circular in outline, the sides not abruptly elevated but gradually rising, with a larger or smaller shallow depression at top which is often furnished with a small central nipple. Color, yellowish-green in fresh, and more yellow in dried specimens; surface opaque, rugose. Gall woody and hard, the wall at the bottom about 1^{mm} in thickness; that of the roof about ½^{mm}. Cell formed as in the preceding species, but much larger; mode of issuing of mature pupa also as in the preceding.

There is no difficulty in recognizing this gall, especially from its appearance on the upper side of a leaf.

41. *P. celtidis-mamma* Riley (Johnson's Universal Cyclopædia, 1876, p. 425; Canad. Ent., v, 15, 1883, p. 158; J. Fletcher in Rep. Ent. Soc. Ont. for 1882 [1883], pp. 79, 80).—This gall, on upper side of leaf, is represented by a very regular cup-shaped impression, measuring on the average 4.5^{mm} across, with the upper, outer rim always regularly circular, and not, or but slightly, elevated above the surface of the leaf; at the bottom of the cup a small median nipple (often obsolete); walls of the impression greenish, the bottom more yellowish.

On the under side of the leaf it is much larger than in any of the other leaf-galls, conical, either slightly narrowing apically or, more frequently, slightly enlarged. The sides are vertical or nearly so; the top broadly rounded without median depression or central nipple. Size very variable; averaging in height 6 to 7^{mm}, and in diameter at base 4 to 5^{mm}. Color pale greenish yellow, with the tip more brownish; surface opaque, rugosely reticulate; at base often covered with a whitish pruinescence, rarely with a few scattered hairs near the top. (Fig. 202, *a*.)

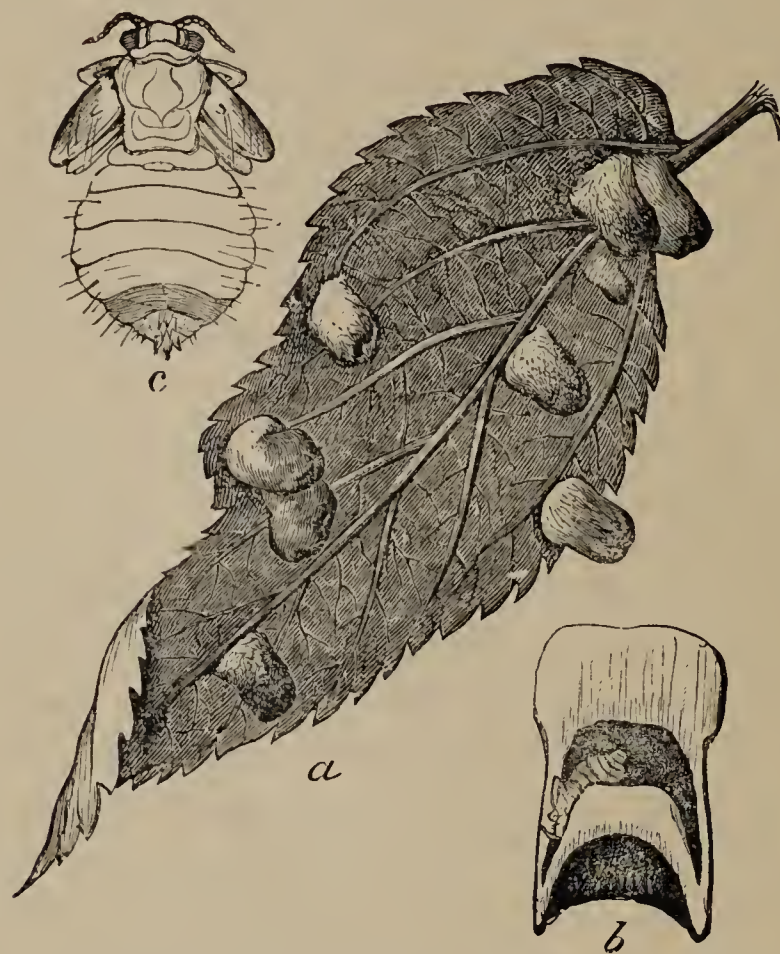


FIG. 202.—Gall of *Pachypsylla c.-mamma*: *a*, leaf with galls from underside—natural size; *b*, section of gall showing cup-like depression, and insect in cavity; *c*, pupa—enlarged. (After Riley.)

The walls of the gall are hard and woody, at the bottom averaging 1.75^{mm}, at the roof 0.75^{mm} in thickness. The cell (Fig. 202, *b*) is large, and in cross-section much more crescent-shaped than in the preceding species. The mature pupa issues through an oval slit sawed through the roof, always near the side where the wall is less thick.

42. *P. celtidis-pubescens* n. sp.—This gall on the upper side of the leaf is represented by a small circular cup-shaped

impression, surrounded by a rather wide, thickened, and elevated margin, and furnished at the bottom with a small, usually star-shaped, median nipple. The bottom and sides of the impression are



FIG. 203.—*Pachypsylla c.-mamma*: adult—enlarged. (Original.)

smooth and shining, and occasionally beset with a few scattered hairs; the elevated margin is coarsely rugose-plicate, and usually also shining. Average diameter of gall, including elevated rim, about 3^{mm}; without the latter, nearly 2^{mm}. On the under side of leaf it is usually semi-globular, entirely sessile, sometimes more flattened, rarely more globular and then less sessile. Surface more or less rugose, not shining, and covered with long but not densely placed white woolly hairs. There is sometimes a small apical nipple surrounded by a slight depression. Average diameter, 3^{mm}. Color pale greenish-yellow. The walls are very thin, but much thicker than the leaf itself; the roof is straight and the cell comparatively large and crescent-shaped in a cross-cut. Mode of issuing of mature pupa as in the preceding.

43. *P. celtidis-globulus* n. sp.—A gall on the upper side of the leaf represented by a very circular hole with vertical walls near the top and widening internally; the rim is not thickened, but is vertically elevated above the leaf surface around the opening. The walls and bottom of the excavation are without decided sculpture and of a lighter color than the leaf; the elevated rim is of the same color as and not thicker than the leaf. Average diameter 1.75^{mm}. On the under side of the leaf the gall is globular or slightly more pyriform and almost stylate, or slightly more flattened and more sessile. There is a larger or smaller shallow apical depression without central nipple, but sometimes limited by a raised rim. Surface a little shining, finely rugose and not pubescent, rarely furnished with a solitary hair. Average diameter 3.3^{mm}.

I have only a single leaf covered with these galls received from Columbia, S. C., collected in the month of September. No imago has been reared therefrom.

This is at once distinguished from the preceding species by the very deep vertical impression on the upper side of the leaf and its globular smooth form on the under side of the leaf.

44. *P. celtidis-cucurbita* n. sp.—This gall, on the upper side of the leaf, forms a cup shaped impression, deeper than in *P. c.-mamma*, but less deep and with the walls less vertical than in *P. c.-globulus*; the cavity is also not widened internally. The outer rim is not sharply limited and not elevated except in one specimen, where it is thickened and bulging as in *P. c.-pubescens*. The walls and the bottom of the cup are not distinctly sculptured and of a greenish-yellow color (in dried specimens), the rim being reddish yellow and rugose. Average diameter, 1.75^{mm}. On the under side of the leaf it arises from a rather slender, but not stylate, base and widens gradually to the middle, thence gradually narrowing toward apex. When viewed from the side the outline of the gall is therefore oval, but the top is always truncate. The sides near the top are furnished with short ribs, which are separated from each other by wide shallow depressions; the apex is formed by an acute rim, which surrounds a cup-shaped depression varying in size and depth according to specimens. Surface neither pubescent nor shining, but finely and indistinctly strigose. Color (dried specimen)

rather bright yellow, brownish near center. Average height of gall, 4^{mm}; diameter, 3.3^{mm}. Cell as in *P. c.-mamma*, the bottom wall at center much less thick than at sides.

P. celtidis-cucurbita var. ?—Gall as seen on the upper side of leaf either as in *P. c.-cucurbita*, or more often as in *P. c.-globulus*, i. e., the impression is vertical and widening internally, but the upper rim is either barely or not at all elevated. On the under side of the leaf it is always sessile, not oval in outline, but depressed and button-shaped; the disk being greatly flattened and with a shallow depression having a small central nipple and surrounded by two concentric rims, the inner one often obsolete, the outer one rarely so. The sides of the gall have either faint longitudinal furrows or are irregularly rugose. Size very variable; average height, 1.75^{mm}; width, 3^{mm}.

Whether or not this form is specifically distinct from the typical *P. c.-cucurbita* can not yet be decided. Of the latter I have not many specimens, all from Missouri; while of the variety I have numerous specimens from Missouri and Texas. No specimens strictly intermediate have yet been found.

Besides the galls just described I possess single specimens which apparently represent other species, but their description is postponed until more complete material can be obtained.

The life-history of these *Pachypsyllas* varies somewhat with the species, but the following summary from my notes gives the essential facts:

Most of the imagos issue in the fall of the year and hibernate in the cracks or under the bark of the tree. The sexes pair in early spring, and as soon as the young leaves put forth, the eggs are deposited singly either on the upper or under sides of the leaf. The young larva settles on the upper side of the leaf and inserts its beak in one of the pores. The irritation from the puncture causes an abnormal growth of the leaf substance, swells around the insect, so that this last appears to sink into the leaf and is gradually carried with the growing gall to the under side. The gall in all *Pachypsyllas* is due to the action of the young larva, and not to the insertion of the egg. The gall itself soon becomes quite perceptible, but the growth of the larva is very slow in the early part of the season. After the month of July the larva develops more rapidly, and toward the end of September or in October the full-grown pupa with its abdominal spines saws an oval or slightly crescent-shaped opening through one side of the roof of the gall, issues therefrom, and changes to imago immediately afterwards. Many pupæ remain in the galls and fall to the ground with the leaves, where they mostly perish, but some succeed in hibernating and change to imago in early spring.

OTHER HACKBERRY INSECTS.

Some few other insects occur on *Celtis*, but they are not important and I have so far found no time to work at them.



